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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE PRESIDENTIAL ADDRESS[1]

Ladies and Gentlemen:

My first duty, as president of our great association, must be to read to you the following message from His Majesty The King:—

I am sensible of the distinction conferred upon my dear son, The Prince of Wales, in presiding at this year's meeting of the British Association for the Advancement of Science; for I realize that no member of my family has occupied this position since my grandfather was president in 1859. I can not do better than repeat the assurances then made by the Prince Consort on behalf of Queen Victoria, and express my deep appreciation of the all-important and ceaseless labors in the cause of science of those eminent men who enjoy the membership of your world-renowned society.

I propose on behalf of the association to forward the following reply to this message:

The members of the British Association for the Advancement of Science assembled at Oxford humbly beg to express to Your Majesty their loyal appreciation of the patronage extended to the association by your Father and Yourself, and of Your Majesties' repeated expressions of personal interest in its work.

The advancement of science is the constant object of the British Association; to give a stronger impulse and more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers, to obtain a greater degree of national attention to the objects of science, by removing those disadvantages which impede its progress, for the well-being of Your Majesty's realm and the general good of mankind.

My second duty is to try and tell you—if this be possible—something which you do not know already. I must admit frankly that, for a long time, the prospect of attempting this has weighed on me heavily. For a man who, along with the great majority of his fellow-creatures, can lay claim to no intensive scientific training, it is no light responsibility to be called on to address the annual gathering of the British Association. But, believe me, I do not intend to shirk that responsibility; for it seems to me that only

[1] Given by The Prince of Wales, Oxford, August, 1926.

by discharging it as well as I possibly can, shall I be able to show you how highly I value the great honor you paid me, when you added my name to those of the distinguished men who have been your Presidents in past years.

At first sight, it might appear a hopeless task for any one who knows nothing of science to talk to you, who know everything about science. But those who work in the scientific field will be the first to admit that no task is really hopeless, and, when I approached this one, I began to think I might perhaps find a few topics in which I could interest you. For, after all, science is only another name for knowledge, and any man who goes about the world with his eyes open can not fail to acquire knowledge of some sort, which, if he can express it, must appeal to any audience.

To adapt one of our most familiar sayings, the onlooker can see a great deal of the game. And I, for instance, though I claim no insight into pure science, can fairly claim an onlooker's experience of very many practical instances of science as applied to the needs of our civilization to-day. For some years past, in war and in peace, I have been privileged to have countless opportunities of examining, at close quarters, the concrete results of such applied science. In things military and naval, in factories, workshops, mines, railroads, in contact with the everyday problems of education, health, land-settlement, agriculture, transport or housing—in all such varied departments of human life, it has been borne in on me more and more that if civilization is to go on, it can only progress along a road of which the foundations have been laid by scientific thought and research. More than that, I have come to realize that the future solution of practically all the domestic and social difficulties with which we have to grapple nowadays will only be found by scientific methods.

It is from this experience, and with the conviction it has brought, that I should like to-night to tell you something of my general impressions of the bearing of scientific research on the daily life of the community; and to show how that relationship can be developed by the mutual cooperation of scientific workers and the state. I can not better embark on this attempt than by quoting to you the words of my distinguished predecessor, though without the hope that what follows will maintain the high standard which he set in his presidential address at the last meeting.

Professor Lamb, on that occasion, expressed confidence that the efforts of scientific workers "have their place, not a mean one, in human activities, and that they tend, if often in unimagined ways, to increase the intellectual and the material and even the esthetic possessions of the world. And in that assurance (he continued) we may rejoice that science has never been so widely and so enthusiastically cultivated as at the present time, with so complete sincerity, or (we may claim) with more brilliant success." This claim, by no means exaggerated, invites reflection upon the intimate association of the results of scientific research with the daily lives and affairs of every one of us. And it is a good thing to reflect upon this, even for those who have no sort of direct contact with scientific research, if only because the doing so may dispel an attitude towards science, which personifies it somewhat as the ancients personified the powers of darkness, and invests it with some of their sinister attributes. Such an attitude of mind is fortunately less common than it used to be. Professor Lamb, in the address already quoted, referred to a certain feeling of dumb hostility toward science and its works, which still survives. No doubt it does; but at least it has ceased to be vocal, as it was in the earlier days of the association. It became loud (for example) at two of the meetings in this very place. The later of these two occasions was the Oxford meeting in 1860, and the field of battle was the section of botany and zoology, in which the theories put forward in Darwin's "Origin of Species" were debated, in a manner which has passed into history, between Wilberforce, Bishop of Oxford, on the one hand, and Huxley and Hooker, on the other.

The earlier occasion, however, more appropriately illustrates, by contrast, the modern realization of our debt to science.

The second meeting of the association, in 1832, took place in Oxford. The university was not, at that time, without distinguished cultivators of science. The invitation to Oxford came from Charles Daubeny, who combined the professorships of chemistry, botany and rural economy, and the president was William Buckland, then canon of Christ Church and professor of mineralogy and geology. But a strong body of opinion resented the recognition of science by the university when carried to the extent of conferring honorary degrees upon four of the distinguished visitors. The famous Keble, moved for once to anger, referred to those who were thus honored as a "hodgepodge of philosophers." Their names were David Brewster, Robert Brown, John Dalton and Michael Faraday. Each of these men has left in the history of his own special branches of science an outstanding memorial. Brewster's researches into optics were his greatest scientific achievement; to our own gratitude he has an especial claim as the leader among the founders of our association. Brown's services to botany were unsurpassed; perhaps that of widest appeal is his very thorough investigation of the flora of the coastlands of Australia, made during the voyage

on which he accompanied Flinders in 1810–14; an early example of what may be termed imperial research. Dalton's name is identified for ever with the atomic theory, and he placed meteorology on a scientific footing. Faraday's labors provide one of the most wonderful examples of scientific research leading to enormous industrial development. Upon his discovery of benzene and its structure the great chemical industries of to-day are largely based, including, in particular, the dyeing industries. Still wider applications have followed upon his discovery of the laws of electrolysis and of the mechanical generation of electricity. It has been said, and with reason, that the two million workers in this country alone who are dependent upon electrical industries are living on the brain of Faraday; but to his discoveries in the first instance many millions more owe the uses of electricity in lighting, traction, communication and industrial power. Oxford, then, was not dishonored in the hodge-podge of philosophers whom she recognized in 1832. Nor will she recall with any disfavor the singularly doubtful compliment paid her on that occasion by another distinguished visitor, in whose mind the opposition must have rankled; the university, he said, had prolonged her existence for a hundred years by the kind reception he and his fellows had received. The association will scarcely make that claim to-day. But its visiting members will have ample opportunity to learn how, through her museums and laboratories, Oxford, within the hundred years thus tolerantly allotted to her, has kept pace with the scientific development of the period. It need surely be no matter for regret if science has worked for and is taking a place, not only in the university but in the schools, complementary with that occupied by the humanities. For complementary these two branches of learning must ultimately be. All the greatest exponents of scientific learning have been men of attainment also in letters.

The services rendered to mankind by the labors of outstanding figures in science, such as Faraday, or Kelvin, or Pasteur or Lister, are matters of too common knowledge to need insisting upon in this place. What is perhaps less generally appreciated is the extent to which, through the efforts of very numerous workers, the results of scientific research have been brought to bear upon many of the most pressing domestic and industrial problems of the day, and that the cooperation between the laboratory and the state (which means the community) has been greatly strengthened of recent years. The British Association has always supported such cooperation. One of its principal aims, as stated by its founders and maintained ever since, is "to obtain more general attention for the objects of science and the removal of any disadvantages of a public kind which impede its progress." In an article contributed by Brewster to the *Quarterly Review* in 1830, he asserted frankly that "the sciences of England" were "in a wretched state of depression, and their decline is mainly owing to the ignorance and supineness of the government" as well as to various other causes which he detailed. The same theme (if less forcibly stated) recurs in some of the earlier addresses from the chair of the association: the Prince Consort, for example, as president in 1859, thus indicates his view of the situation at that time—"We may be justified in hoping," he said, "that by the gradual diffusion of science, and its increasing recognition as a principal part of our national education, the public in general, no less than the legislature and the state, will more and more recognize the claims of science to their attention; so that it may no longer require the begging-box, but speak to the state, like a favored child to its parent, sure of his parental solicitude for its welfare; that the state will recognize in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand."

It may be fairly said that the position foreshadowed in those words is now, in a large measure, attained. The progress toward it was visible, if slow, down to the end of the last century; but the beginning of a new era was then marked by the establishment of the National Physical Laboratory. This was at first set up in Kew Observatory, a building which, as a laboratory for magnetic and meteorological observations, and for the standardizing of instruments, owed its maintenance to the British Association for thirty years from 1841, when, as a royal observatory, the government decided to dismantle it. The building proved incapable of extension to accommodate the whole of the work, and in 1900 Bushy House, Teddington, was placed at the disposal of the laboratory by the Crown. The laboratory, at its inception, was divided into departments dealing with physics, engineering and chemistry, and it possesses also the famous William Froude experimental ship tank. The investigations with which it has been so largely concerned—the testing and standardization of machines, materials and scientific instruments, researches into methods of measurement with the utmost accuracy, work on scale-models of ships, and the like—while of the first importance to government departments concerned with such applications of science, have also achieved many valuable results for industry in improving standard qualities, in indicating scientific methods applicable throughout a variety of manufactures, and thus in bringing about an improvement in the quality of their output for the benefit of consumers—which is to say, ourselves.

In historical sequence among the events which have strengthened interaction between science and the state, there follows the establishment of the Development Commission in 1908. Until that date the only agency for agricultural research in Great Britain was the classical experimental station at Rothamsted, a private benefaction; and the expenditure of the state on this prime factor in national economy was trifling. Since 1908 the Rothamsted station has been expanded to cover the whole field of nutrition and disease in the plant, while other institutes have been founded to deal with other aspects of agriculture such as plant breeding, the nutrition and diseases of animals, agricultural machinery and the economics of the industry. Not only are these institutes providing knowledge for our own farmers, but they form the training-ground for agricultural experts required by the Dominions, India and the Crown Colonies, which need no longer look abroad for their advisers. At the plant-breeding institute at Cambridge, Sir Rowland Biffen has provided several new wheats, of which two are generally grown throughout the country; the extra yield and value of these wheats must already have more than repaid the whole expenditure on agricultural research since the institute was founded. Among other examples of the value of research there may be mentioned the discovery of a variety of potato immune from the ineradicable wart disease, which a few years ago threatened the principal growing districts. The clearing up of the confusion into which commercial stocks of fruit trees had fallen has ensured that growers may plant orchards upon uniform stocks suitable to the soil and climate. And among the most important inquiries are those into the production and cleansing of milk, which have resulted in an entire reform of rationing, increasing the yield of each cow by one to two hundred gallons a year, and in freeing milk from the risk of contamination with disease.

Research into fisheries (which are administratively associated with agriculture) has become a matter of necessity in the light of evidence that even the vast resources of the sea have their limit, and can be injured if they are not exploited with due care and knowledge. Great Britain, acting in cooperation with the other nations who share with us the northern seas, has accomplished much in ascertaining the causes of the fluctuating herring supply, and has contributed notably to the study of the methods by which the stocks of plaice can be maintained. Research again is active in finding methods by which we can mitigate one of the consequences of our dense population—the pollution of our rivers and estuaries, and a method has been found whereby great supplies of shellfish that had been condemned are once more available as food. Some of my hearers will know, too, of the remarkable results obtained from the scientific study of the habits of the salmon. Though fishing has been described as "a fool at one end of a string and a worm at the other," the subject is not without its personal interest, I believe, to many learned men.

Reverting to the historical sequence, it is appropriate to recall, with gratitude for its labors, the constitution of the Medical Research Committee in 1913, under the Insurance Act of 1911: this has since (in 1919) been transferred to a committee of the Privy Council under the name of the Medical Research Council, and its funds are directly voted by parliament instead of being drawn from the contributions made by or on behalf of insured persons.

Research alone could provide the knowledge on which must be based all wise and effective legislation or administrative action in the interests of the nation's health. Yet until 1913 the state had played at best a subsidiary part in the organization of such research and the provision of its material support. Under the new conditions the state is actively concerned with the promotion and coordination of medical research towards conquest of those infirmities with which ignorance has afflicted humanity. A few only may be mentioned, which have rightly appealed to wide public interest. Insulin, a gift to science and to humanity from young enterprise and enthusiasm in the Dominion of Canada, is not only saving lives that were threatened, and restoring almost to normal health and enjoyment many that were crippled by weakness and restriction, but, as a tool of investigation, is shaping new knowledge that will influence all our ideas of the functions of the body, in health or disease. The discovery of the vitamins, those still mysterious and minute constituents of a natural diet, has brought understanding of various defects of health and of development, created for us largely by the blindness of civilization to dangers accompanying its progress, dangers which science can avert. Closely linked with the discovery has been the more recent development of knowledge concerning the need of sunlight for health, in man and his fellow animals as in plants. We know now that crippling deformity appears in the growing child unless he receives his proper share of the vitalizing rays of the sun, either directly or through the presence in natural foods of vitamins which these rays have produced. Sunlight, or its artificial equivalents, have some importance already in the treatment of disease; but a realization of its significance for health has a much greater importance in preventive hygiene. There can surely be no plainer duty, for a state charged with the health of an industrial civilization, than to promote with all its resources the search for such knowledge as this, as well as to provide for its application when obtained.

Among diseases which painfully affect the popular

imagination, cancer has an evil preeminence, largely on account of its mysterious, and therefore seemingly inevitable nature. For many years past a volume of investigation, supported by private benefactions and organized charity, has patiently accumulated knowledge of the beginnings of cancer and the conditions of its growth. Now, at length, there are signs of more rapid progress towards a penetration of its secret. Patience and caution are as necessary as ever; a new and exacting technique is still in development; but there is a new spirit of hope and enthusiasm. And it is reassuring to know that in this, as in other directions, the state is giving its direct support to investigation, and cooperating with the foundations due to private generosity.

Looking backward a dozen years or so, one may say that science was definitely, by that time, a working part of the machinery of the state, though, as we see now, not a part working at full power. The great war caused a broadening, so to speak, of the scientific horizon for men of science themselves in some measure, but for the layman in a measure far greater. We all were brought to recognize the applications of science as adding, it may be, in certain respects to the distresses of warfare; but also as immensely alleviating the sufferings caused by it, and as indicating many methods of strengthening the arts of defense—some of which methods are no less valuable in strengthening the arts of peace. The creation of the Government Department of Scientific and Industrial Research was an act which falls, historically, within the period of the war; but as an outstanding incident in the scientific advancement of national affairs, it certainly is not to be regarded as merely a war measure; it was once described as a near relative of "Dora," but that was a mistake. Nevertheless, by an odd freak of history, it needed the whole period of a century between one great war-time and the next—between the Napoleonic and the world wars—to mature the conception of a state department of scientific research. Some idea of this kind was clearly present in the mind of Brewster, and certain of his contemporaries, concurrently with his idea of the foundation of our own association in 1831; and later (in 1850) when he addressed the association from the chair, he claimed a strong advance in scientific and public opinion toward his views. Five years later a concrete proposal for the creation of a board of science, possessing "at once authority and knowledge," was put forward by the parliamentary committee of this association (a committee no longer existing); but our council at the time considered that the proposal had "yet to receive sanction from public opinion, and more especially from the opinion of men of science themselves." It was not, in fact, entirely owing to lack of prevision on the side of successive governments that the developments which have been outlined were so long delayed. There was an element of mutual distrust between science and the state—now, it may happily be believed, almost if not quite wholly removed. A strong body of scientific opinion was avowedly afraid (as Sir George Airy phrased it) of "organizations of any kind dependent on the state." It is to be hoped that modern developments have removed that fear. The progress of science can not be kept wholly within training-walls, and no one wants to try to keep it so. The waters of a river may be guided artificially to do the work of irrigation; but not at their sources, nor yet where, at the last, they percolate the soil. The guidance of scientific research, in its inception, lies with the genius of the individual; its results for the future may lie far beyond the realization even of the scientific workers themselves. The Oxford meeting of the association in 1894 supplies a simple example of this. There was a discussion on flight, in the section of mathematics and physics, opened by Hiram Maxim; and no less a leader in science than Kelvin afterwards described Maxim's own flying machine as a child's perambulator with a sunshade magnified eight times. Yet it was not many years before research in aeronautics had become the care of the state as well as of the individual; and the work carried out before 1914 under (what is now) the Aeronautical Research Committee led on to our wonderful development of aircraft during the war.

A recent report of the committee of the Privy Council for Scientific and Industrial Research shows that under the department there are eleven research boards, some of which direct the work of committees to the number of three dozen in all. These boards coordinate and govern researches in chemistry, fabrics, engineering and physics, radio, building, food-investigation, forest-products and fuel; and to these are to be added the board of the Geological Survey and the executive committee of the National Physical Laboratory. Under the general supervision of the Advisory Council there are upwards of twenty industrial research associations, formed in alliance with the same number of the principal industries of the country, for the purposes of scientific investigations connected with those industries. No attempt can be made here to review the whole field of work of these various bodies; but a few examples may be chosen for the purpose of pointing out what may be called their homely application. First, then, as to the building of the home. The Building Research Board was created in 1920, and in 1925, at the request of the Ministry of Health, considerably extended its activities. Researches are concerned with the study of materials from the chemical and geological aspects, their strength, weathering, moisture condensation on wall coverings, acoustics and

various other problems; these inquiries, together with the collection and supply of information both by publication and through an intelligence bureau, represent (as the report states) "an attempt to create a real science of building, to explain and supplement the traditional knowledge possessed to-day in the industry." It can scarcely be questioned that industrial Britain inherits a legacy of discomfort in the housing of its workers, with all which that implies, dating from a period when the building of the home lacked scientific as well as esthetic guidance. We need that guidance no less to-day, when the saving of labor is one of the main objectives of the "ideal home" and its fitments.

Next, a further word as to our food supplies. The Food Investigation Board directs committees concerned with meat and fish preservation, fruit and vegetables, oils and fats and canned foods. There is also a committee for engineering problems associated with the investigations; conditions of storage have been investigated on ships between this country and Australia, and problems of heat-conductivity at the National Physical Laboratory, while chemical substances suitable for refrigerants have been studied at the Engineering School here in Oxford. At Cambridge a low-temperature research station has been established on ground given by the university, and is working in cooperation with the university biochemical, botanical, agricultural and other laboratories. As for the investigations upon fruit and vegetables, the report may again be quoted, for it illustrates in a sentence something approaching the ideal of scientific cooperation brought to bear upon one particular home necessity, and (what is more) upon a particular and important branch of imperial commerce. "There is (it says) a closely knit scheme of work, which rests, on the one hand, in university schools of botany, and, on the other, in commercial stores scattered all over the country, where accurate records of results and conditions have been kept, and extends to the conditions of transport by ship, and overseas so far even as the Australasian orchards." Other directions of research which touch upon commonplaces of our daily life are those concerned with fuel, with illumination, with the deterioration of fabrics and the fading of colored stuffs, and—perhaps most homely example of all—with the application of scientific methods in the laundry industry. This will be good news to those of us who may have suffered, or may even be suffering to-night, from the torture of a collar which comes back from the wash with an edge like a surgical saw. It must be clearly understood that the few instances mentioned represent only a small fraction of the present activities of science in cooperation with the state. And expressed as they are here expressed, they may appear to wear an aspect even of triviality, because they deal with common things. But it is precisely because they do deal with common things that they are not trivial. There may be matter for amusement in that fact that science is concerning itself with the contents of the clothes-basket; but there is also matter for congratulation, and there may, in the future, be matter for sincere gratitude. Scientific research, properly applied and carried out, is never wasted. It may prove that a thing can be done, or that it can not be done; but even the proof of a negative may save the waste of further effort.

This attitude of the state toward science makes for an easing of the paths for the advancement of science in many directions; it marks a definite step in human progress, taken after long hesitation, but in itself new; and because it is new, we may believe with some reason that we live, not merely in an age of science, but at the beginning of it. The movement for cooperation which we have been discussing is not confined to this country. It has borne fine fruit already in other lands; and in particular it is active in our own dominions. The Indian Empire stands in a somewhat different category from these: there is here a tradition, so to say, for the application of science in its government, and the scientific results of its census investigations, its surveys, its agricultural, forestry and other administrative departments have long been famous. This is not to imply that brilliant scientific work has been wanting in the dominions—far from it—but the cooperative movements with their governments have followed that in this country and with a laudable promptitude. The trend of developments following upon all these movements has been similar broadly speaking; it is sought to take a comprehensive survey of the natural resources and industrial opportunities of each dominion, to explore the means by which science may be best applied to their exploitation, to provide, whether in state institutions or in university and other laboratories, for the pursuit of the necessary researches, to coordinate the work, and to ensure the dissemination of knowledge acquired. The nature of the researches themselves is conditioned to a large extent (though by no means wholly) by geographical circumstances in the respective territories: agricultural, pastoral and forestry problems, for example, are not identical in all of them, and that very fact adds to the interest and value of coordinating the results of research work throughout the empire. While problems may differ, solutions may point to a common end. Nothing but good can follow from personal contact between scientific workers in different parts of the empire. Nothing but good can follow from their researches if they add, as gradually they must add, to the wider knowledge of the empire not only among the workers themselves, but ultimately

among the whole body of informed imperial citizenship; not only in the overseas territories, but here at home. For us at home the empire is worth knowing. Our knowledge of it begins with the school lessons in geography and history—or should do so; no doubt the ideal here is yet to be attained. Such knowledge may become later of vital importance to those who wish to join the stream of overseas migration. The British Association, in pursuit of its policy of obtaining from time to time "reports on the state of science" in one department or another, has recently, through a committee of the Section of Educational Science, been collecting evidence as to the facilities existing in our schools for training boys and girls for life overseas. In the crowded curriculum of most schools these facilities, at any rate in their particular imperial application, are not conspicuous. Yet any labor which time allows us to spend, whether in school days or after them, upon the advancement of scientific knowledge of the empire, of the means and manner and environment of life in its component territories, must be well spent. The British Association has played its part in this advancement since, in 1884, it admitted the principle and established the practice of holding occasional meetings overseas. Those of our members who traveled from this country to take part in these meetings have had peculiar opportunities to meet and discuss each his own scientific problems with fellow-workers in the dominions—and it should be added with particular reference to those meetings which have been held in Canada that they have provided almost unique opportunities for personal contact between British workers in science and their American colleagues. Our traveling members have been able to see how science is cultivated in the universities of the dominions and in many other institutions; they have gained first-hand acquaintance with the special problems of one territory and another; and when they have returned home they have talked—as any one who travels the empire is impelled to talk. I have myself been guilty of giving way to this impulse on more than one occasion. Opportunities for travel are none too common for most of us, but most of us can at least cast our minds back to the exhibition at Wembley. Science herself, as an exhibitor, took a place there befitting her natural modesty. The scientific exhibit arranged by the Royal Society, admirable as it was, was confined to two rooms of the Government Pavilion. But was not a very large proportion of the entire exhibition, in point of fact, an exhibition of applied science?

It is impossible in the imperial connection to overstate the case for science. Sir William Huggins, in his presidential address to the Royal Society in 1901, said that "assuredly not only the prosperity, but even the existence of this empire will be found to depend upon the more complete application of scientific knowledge and methods to every department of industrial and national activity." To-day we see that application in much fuller progress than when Huggins spoke only a quarter of a century ago, and already we know how truly he prophesied.

It is not for a moment to be supposed, because the state has come to take a more active and practical interest in scientific research, that there is therefore any occasion for the lessening of interest on the part of societies and individuals. The state interest involves that other interest, and invites it. It can never become the exclusive function of the state to aid the individual research worker. The state may, and does, cooperate in aiding him, as for instance through the universities and the Royal Society. Nevertheless, there are whole departments of research which do not come within the range of public assistance, but are no less valuable because they do not. Therefore the support of science remains the concern of our scientific societies, educational institutions, industrial organizations and private benefactors, no less than it ever did; nay, the very fact that the state has lent its aid should encourage them to continue their aid and to reinforce it—indeed, there is satisfactory evidence that this actually happens. One example will suffice which indicates, incidentally, that from the purely materialistic point of view scientific research is not a luxury; for the community it is probably the cheapest possible form of investment. The government's fuel research station has not yet proved the commercial possibility of the low-temperature treatment of coal which would result in the more economical production of smokeless fuel, oils and gas; but in attempting this difficult task it has already, by results unforeseen when the task was undertaken, shown at any rate the possibility of economies for the state and for some of its major industries which are well in excess of the cost of the research itself.

There are parallels in many respects, as has been often pointed out and as often forgotten, between the periods of our history following the Napoleonic Wars and the Great War. The application of science in industry and daily life received impetus in the earlier of these periods in such directions as the introduction of steam motive power; it is receiving it now, as it has been attempted here to show. The auspices now are more favorable. Science is more powerful. Men more adequately and more generally recognize its power, and therein should lie a certain ethical value for it as offering a new point of view, in the manifold interest of which all can share. Should not the application of science, for instance, offer a new field for community of interest, not only

between one industrial organization and another, but within the whole body of workers in any single organization? But in order that the community may fully realize all that it owes, and all that it might owe, to the advancement of science, the channels of communication between research and the public mind have to be kept clear, maintained and widened. The non-scientific public is accustomed to view science as it might view a volcano; prepared for the eruption of some new discovery from time to time, but accepting the effects of the eruption without realizing the processes which led up to it during the preceding period of quiescence. The period of preparation by research before science can offer the world some new benefit may be long, but the scientific machine is always running quietly in the laboratory. There is an example ready to our hands. We recall the introduction of wireless telegraphy and telephony as a scientific gift of quite recent years. Do we all realize that it was here in Oxford, at the meeting of the British Association so long ago as 1849, that the first public demonstration of wireless signalling by means of electro-magnetic waves was given by Sir Oliver Lodge? It was the work of science to develop the methods then demonstrated until they have been brought to their present marvellous uses. On the other hand it is often the case, whether in industrial or agricultural, domestic or whatever application, that science has knowledge at command, awaiting use, long before mankind can be brought actually to apply it. Though we have quickened, we are not yet so quick in the uptake of the results of applied scientific research as, for instance, some of our commercial competitors. The public support of scientific research, upon all these grounds, should be accorded freely, with understanding, and with patience.

This brings me, ladies and gentlemen, to the close of what I have to say to you this evening. From my opening remarks, you will have gathered that I looked on you as an extremely formidable audience. That was when I only knew you, so to speak, on paper. Now that I have met some of you face to face—and hope to meet others in the Town Hall in a few minutes—I can only say that, if the presidential address has not the traditional weight of knowledge behind it, no president in the history of the association has ever received a more kindly and sympathetic welcome than you have given me to-night. I am deeply grateful for it.

One more duty remains to me—a duty to our hosts and to our guests. The university and city of Oxford have received us all with a high hospitality worthy of this town, to which all who have known it in the past always return with delight, and which never fails to throw its spell on those who see it for the first time. Their friendly reception has made it possible for those who have worked so hard at the organization of this meeting to bring it to the successful culmination which it promises to attain. Not the least successful feature of it is the large number of distinguished guests whom it has attracted from overseas. To all these I wish to offer a most cordial welcome with the sincere hope that they may always carry with them, as I shall myself, the most pleasant recollections of a memorable gathering.

GEORGE D. SHEPARDSON

Professor George Defrees Shepardson, for the past thirty-five years head of the department of electrical engineering at the University of Minnesota, died May 26, 1926, in Florence, Italy. He was absent this year on a sabbatical furlough, which he was spending with his family on a trip around the world.

Professor Shepardson was born in Cincinnati, Ohio, in 1864, the son of Reverend Daniel and Eliza Shepardson, who were the founders of Shepardson College for Women at Granville, Ohio. He graduated from Denison University in 1885 and received a Master's degree in 1888. He graduated in mechanical engineering at Cornell in 1889 and received the degree of doctor of science from Harvard in 1912.

In 1891 Professor Shepardson came to the University of Minnesota to take charge of the work in electrical engineering which was just beginning. The development of this department from that time to the largest of the engineering departments at Minnesota, is due to his leadership. He was the author of many text-books and technical and scientific articles.

He was a member of the jury of awards at the Buffalo exposition in 1901 and at the St. Louis exposition in 1904. He was a member of the American Institute of Electrical Engineers, National Electric Light Association, and the Society for the Promotion of Engineering Education, and a fellow of the American Association for the Advancement of Science. He was a member also of the honorary societies Sigma Xi, Phi Beta Kappa, Tau Beta Pi, Eta Kappa Nu.

Professor Shepardson was married in 1892 to Miss Harriet B. King, of Kings Mills, Ohio, who, with their daughter, Mary, survives him.

He was a cultured, Christian gentleman, very widely read in both the sciences and humanities. All his students will remember him for his readiness to help, his conscientiousness, patience, courtesy and kindness.

O. M. Leland

University of Minnesota

GEORGE E. BEYER; 1861–1926

PROFESSOR GEORGE E. BEYER was born in Meissen, Saxony, on September 9, 1861. He was educated in Dresden and Berlin, a student under Brehm, Staudinger and Engelhardt. At the suggestion of Staudinger he went to Central America in 1880, where he made valuable collections of insects. He never returned to Europe, establishing his permanent home in New Orleans in 1891, where he set up a taxidermy establishment, becoming field agent for the Smithsonian Institution. He was connected with the biological department of Tulane University from 1895 until 1918, becoming full professor of biology in 1912. In 1918 he became medical entomologist with the Louisiana State Board of Health, which position he held until his death on June 2, 1926. He had been in ill health for about two years.

Professor Beyer belonged to that grand old school of all-round naturalists, who studied all phases of natural history before these days of ultra-specialization. He was one of the pioneers in mosquito and yellow fever investigation, and took part in the successful and final yellow fever mosquito fight in New Orleans in 1905. He was sent to Vera Cruz to study yellow fever as assistant surgeon with the U. S. Marine Hospital Service, and later as special inspector for the U. S. Department of Agriculture. He was one time president of the Louisiana Naturalists Society and also of the Louisiana Audubon Society and a fellow of the American Ornithological Union, the American Microscopical Society and the American Public Health Association as well as other scientific societies of his day. His publications were largely in the field of archeology, herpetology and ornithology of Louisiana, and medical entomology.

Professor Beyer was an expert scientific artist and taxidermist and many of the products of his handiwork will be handed down for generations in the Tulane University Museum, which he virtually built single handed. His taxidermy was far superior to that of the standard of his day, his skill as a trained taxidermist being not only combined with an artistic faculty but he being an accomplished and enthusiastic scientist as well. His museum preparations display his great breadth of vision and his manifold interests, and his plan of arrangement emphasizes a faith in the essential monism of the plan of the universe. He was an excellent lecturer and a great teacher, contributing a fair share to the advancement of scientific education, and the world is better off for his sojourn therein.

PERCY VIOSCA, JR.

NEW ORLEANS, LA.

SCIENTIFIC EVENTS

EXPEDITIONS OF THE FIELD COLUMBIAN MUSEUM

D. C. DAVIES, director of the Field Museum, recently made a report to the board of trustees on the expeditionary activities of the institution for the first six months of 1926. In addition, field work is being carried on or verging on completion in four separate parts of the United States.

This year saw completion of the work of the James Simpson-Roosevelt expedition to Central Asia and the Pamirs, "roof of the world." The expedition, financed by James Simpson and headed by Theodore and Kermit Roosevelt, and George K. Cherrie, with C. Suydam Cutting, big game hunter, as volunteer photographer, bagged many large mammals, including eight specimens of the rare Marco Polo sheep. Numerous birds, reptiles and small animals were also obtained.

The Rawson-MacMillan Sub-Arctic expedition is now in Greenland and is headed for Baffinland and other sub-Arctic lands in search of zoological, anthropological, geological and botanical materials. Donald B. MacMillan, the Arctic explorer, is leader of the expedition, which is financed by Frederick H. Rawson, a Chicago banker. Accompanying the expedition are Alfred C. Weed and Ashley Hine, of the museum; James H. C. Martens, of Cornell University, accompanies the party as a collector.

Three Brazilian expeditions are being carried on under the patronage of Captain Marshall Field. The Brazilian zoological expedition is under the leadership of Mr. Cherrie. This party includes Karl P. Schmidt and Colin C. Sanborn, of the museum staff, Mrs. Marshall Field, acting as assistant, Mrs. Grace Thompson Seton, historian, and Curzon Taylor, New York, photographer.

Dr. B. E. Dahlgren, acting curator of botany, is heading the botanical expedition to Brazil. This expedition will explore along the Amazon river and some of its tributaries. Dr. Dahlgren is accompanied by J. R. Miller and George Peterson, preparators of the museum staff.

Dr. Henry W. Nichols, associate curator of the geological department of the museum, is leading the expedition to the mining regions of Brazil and neighboring countries, to collect minerals and other geological specimens.

Central Africa has been penetrated by the Conover-Everard expedition in search of large and small mammals, birds and reptiles. The expedition is in charge of H. B. Conover, of the museum, and R. H. Everard, of Detroit. Conover and Everard financed the expedition and are carrying it on under the auspices of

the museum. They are accompanied by John T. Zimmer, of the museum staff. The explorers' itinerary includes Tanganyika, Uganda and the upper Nile.

An expedition to the Belgian Congo, led by Edmund Heller of the museum, is completing its work. Among the 800 mammals secured by this expedition is a fine male okapi, reputed to be the most difficult to obtain of all large mammals now extant.

The Field-Museum-Oxford-University joint expedition is continuing its archeological research in Mesopotamia under the leadership of Professor Stephen Langdon. Plans call for extending the work to include a town now known as Bughatait, 16 miles from Kish. Many rare finds have been made at the latter place. Plans also call for excavating the great temple of the mother goddess of Kish, situated in the eastern part of the city.

Associate Curator Elmer S. Riggs, of the museum, who left on April 10 for Argentina, is continuing the work of the Captain Marshall Field paleontological expedition which was temporarily discontinued last year. Mr. Riggs is directing excavations for prehistoric skeletal remains. He is being assisted by Robert Thorne of the museum staff.

Continuing work started last year, Dr. A. L. Kroeber, research associate in American archeology, is engaged in Peru in determining the culture of early Peruvian civilizations. W. Egbert Schenk, of Berkeley, California, is Dr. Kroeber's assistant.

The botanical expedition to Peru will continue its work of collecting herbarium and botanical specimens under the direction of Dr. A. Weberbauer.

Dr. Ralph Linton, assistant curator of oceanic and Malayan ethnology, is exploring the island of Madagascar and making an ethnological survey, securing collections illustrative of the life and customs of the tribesmen.

The museum will continue to receive materials from the third Asiatic expedition of the American Museum of Natural History, as a result of cooperative agreement. Dr. Roy Chapman Andrews is leader of this expedition.

Clarence J. Albrecht, taxidermist of the museum, is collecting marine groups of the northern Pacific, operating off the coast of the state of Washington. He is making a special effort to secure family groups of sea lions and other seals. The plans also call for him to secure a group of mule deer in southern Utah.

Charles A. Corwin, artist and background painter, who recently joined the museum staff, will visit southern Utah to make studies and notes for a natural background for the mule deer. Corwin also will visit Arizona to secure data for a background painting for the Canyon Diabolo meteorites at the museum. The museum collection includes the celebrated Canyon Diabolo meteorite, weighing more than 1,000 pounds, the largest specimen of its kind thus far recovered.

Assistant Curator Sharat K. Roy is making a collecting trip of the middle Atlantic states in search of fossils of the Cambrian period—the period of earliest known life, having recently collected fossilized stumps of trees, ferns, branches and rootlets of the Devonian period.

Ethnological specimens obtained by M. G. Chandler during his work among the American Indians have arrived at the museum and are being prepared for exhibition. This expedition was financed by Julius and Augusta N. Rosenwald.

Considerable field work, largely for exhibition purposes, is being carried on in the Chicago area by Carl Neuberth of the department of botany. Botanical specimens are being collected in connection with the annual wild flower exhibit.

THE BEIT FELLOWSHIPS

ELEVEN elections to Beit Memorial Fellowships for Medical Research were made at a recent meeting of the trustees. Lord Clarendon was elected a trustee to take the place of Lord Irwin, who resigned on his appointment as governor-general of India. The honorable secretary, Sir James K. Fowler, presented the following report for the year ended June 30, 1926:

During the past year research has been carried on by two senior fellows (£600 per annum), two fourth-year fellows (£400 per annum), twenty-two junior fellows (£350 per annum). The directors of the laboratories in which the fellows have been working speak in the highest terms of the keen interest with which they have devoted themselves to the researches upon which they are engaged and also in some instances of important results which have been either already obtained or which are in prospect of realization. In 1923 the honorable secretary presented a review of the fellowships in relation to medical science and research, covering the period from the foundation of the trust in 1910 to that date. This included a tabular statement showing the after-careers of the first fifty fellows and particulars of some of those elected after that number had been reached.

Dr. T. R. Elliott (assistant honorary secretary) has now completed a record of the after-histories of the whole of the fellows appointed since 1910, and these interesting details will appear in the next issue of the book of regulations, a copy of which will be sent to all who have at any time held a Beit fellowship. As the book of regulations is enclosed with the form of application possible candidates will in future have an opportunity of realizing the kind of men who have held fellowships in the past and the research which in each case they were appointed to undertake, and thus to obtain some idea as to their own prospects of election, and also as to the suitability of the subject which they offer for consideration, having regard

to the fact that these fellowships were founded to promote research in certain special branches of science. Moreover, as years pass, this record may prove of some slight value as an indication of the problems which were uppermost at various periods of time.

The classification of the fellowships into junior, fourth-year, and senior, which was effected in 1922 with a view to remove as far as possible the objection that as originally designed they opened up no career to those possessed of the spirit of research, has now been tested, and it is a source of satisfaction that Dr. David Keilin, lecturer in parasitology in the University of Cambridge, whose researches have proved of outstanding merit, should have been the first to complete the tenure of a Beit fellowship for seven years and thus to show "by his published work his fitness for a scientific career."

In the review of 1923 it is mentioned that "all who are competent to judge are agreed as to the high position which the fellowships now hold in the department of science with which they are concerned, and as to the legitimate satisfaction which may be entertained by the founder of the trust." It is believed that this may now be repeated without hesitation and also that "this foundation still stands for the advancement by research of knowledge for its own sake, apart from its material value."

THE DANIEL GUGGENHEIM FUND FOR THE PROMOTION OF AERONAUTICS

THE Daniel Guggenheim Fund for the Promotion of Aeronautics has announced two grants aggregating $600,000 to California educational institutions. To Leland Stanford University at Palo Alto, a fund amounting to the income from about $300,000 has been awarded, and to the California Institute at Pasadena $200,000, and $10,000 annually for a period of ten years.

The California institutions were notified of the grants by Harry F. Guggenheim, son of Daniel Guggenheim and president of the fund. In his communication to Dr. R. L. Wilbur, president of Leland Stanford University, Mr. Guggenheim outlined the purpose of the grant and said:

> This gift is made also in recognition of the quality of work which is done in your school of engineering by Dean W. F. Durand and his associates, and also because of our belief that in the great educational institutions of California such important contributions already have been made to science that the world is justified in looking there for very great and outstanding results in the near future.

In a telegram to Dr. R. A. Millikan, president of the California Institute of Technology, Mr. Guggenheim, after referring to the purpose of the gift, said:

> This gift is made also as a tribute to the distinguished work in science and education of yourself and associates, and because of our belief that you are developing in Southern California an institution which is destined to make very great contributions to the progress not only of our own country but of the whole world.

A message from Stanford University announced that, in honor of the donor, the university authorities planned to establish the Daniel Guggenheim experimental laboratory of aerodynamics and aeronautic engineering.

A full course for the training of young men in aerodynamics and aeronautic engineering will be established. This course will be an extension of the present work of the university.

Work along three lines, each headed by an expert, is planned as follows: Aerodynamics, structural design and construction and laboratory research. The men to head the first two divisions are yet to be appointed. The laboratory will be directed by Professor E. P. Lesley, who has for a decade been associated with Dr. Durand in the work of the present laboratory.

A message from Dr. Millikan of the Institute of Technology said that a new Aeronautics Building, containing a ten-foot high-speed wind tunnel, would be built at once, at a cost of about $200,000. It set forth that the grant would make possible the following:

(1) Extension of theoretical courses in aerodynamics and hydrodynamics, with the underlying mathematics and mechanics taught by such men as Professors Harry Bateman, Edward T. Bell and Paul S. Epstein.

(2) Initiation of a group of practical courses conducted by the institute's experimental staff, in cooperation with the engineering staff of the Douglas Airplane Company, with the aid of the facilities at the institute combined with those of the Douglas plant.

(3) Initiation of a comprehensive research program on airplane and motor design, as well as on the theoretical bases of aeronautics.

(4) Immediate perfection of the new stagger-decalage, tailless airplane recently developed at the institute, primarily by A. A. Merrill, a radical departure from standard aeronautical design, which in recent tests has shown promise of adding greatly to the safety of flying.

(5) Establishment of a number of research fellowships in aeronautics at the California Institute.

(6) Planning and manning of the new school so as to include the building and testing not only of models for wind and tunnel work, but also of full-size experimental gliders and power planes for free flight work.

MEETING OF PLANT PHYSIOLOGISTS

THE mid-western regional meeting of the American Society of Plant Physiologists was held at the University Farm, St. Paul, Minn., on Thursday, Friday and Saturday, July 15, 16 and 17, 1926. On Thursday and Saturday the plant physiologists met in joint

session with the agronomists; on Friday the two societies had separate meetings, Friday morning's session of the plant physiologists was devoted to demonstrations and the reading of papers on various phases of plant physiological work. The subjects considered were, the production and measurement of light, including polarized light, and fluorescence and phosphorescence, winter hardiness in alfalfa varieties and in apple varieties, methods and apparatus for measuring freezing points and killing points, methods of construction of thermocouples and their use in temperature measurements, use of ethylene in breaking the rest period, tracheal contents of the apple tree and the preservation of fruits and vegetables in their natural color. There were forty-five plant physiologists present at this meeting and much interest was manifested in the program.

Friday afternoon was devoted to an inspection tour. The Linnaean library and the new botany building under construction on the university campus at Minneapolis were visited. Trips were also made through the Washburn Crosby Flour Mills and the banana plant of the E. P. Stacy Co. Friday evening all were entertained by Dr. and Mrs. R. B. Harvey at a picnic dinner on the banks of the St. Croix river twenty-five miles from St. Paul. It was a very pleasant social occasion.

The newly elected officers for the year 1926–27 are, *President,* Dr. Francis E. Lloyd, McGill University; *Vice-president,* Dr. Wright A. Gardner, Auburn Polytechnic Institute; *Secretary-treasurer,* Dr. S. V. Eaton, University of Chicago.

THE INTERNATIONAL CONFERENCE ON FLOWER AND FRUIT STERILITY

This conference is being held in New York City during the present week under the auspices and with the financial support of the Horticultural Society of New York. The organization of the conference has been in the charge of an executive committee consisting of Dr. N. L. Britton, *chairman,* Mr. Frederic Newbold, *treasurer,* and Dr. A. B. Stout, *secretary,* and a local advisory committee consisting of Professor R. A. Harper and Professor H. M. Richards, of Columbia University; Dr. C. Stuart Gager, director of the Brooklyn Botanic Garden; Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research, and Mr. Leonard Barron, editor of *Garden and Home Builder.* Various persons both in America and abroad have rendered valuable assistance in the development of the program.

The conference convened at Columbia University in the auditorium of Schermerhorn Hall, on Thursday morning after an opening address by Dr. N. L. Britton, and an address of welcome by T. A. Havemeyer, president of the Horticultural Society of New York. A program of nine papers was presented. At the close of this session motor busses were provided for the trip to the New York Botanical Garden where lunch was served and a scientific program presented. Afterwards there was opportunity for inspection of the garden.

The sessions of Friday were held at the Boyce Thompson Institute for Plant Research, Yonkers. A smoker with informal discussion was held in the evening. The conference held its sessions on Saturday at the Brooklyn Botanic Garden.

The foreign men of science announced to take part in the conference were: Fred J. Chittenden, director of the Royal Horticultural Society Garden, England; M. B. Crane, The John Innes Horticultural Institution, England; Dr. Kathleen B. Blackburn and Dr. J. W. Heslop Harrison, Armstrong College, University of Durham, Newcastle-on-Tyne, England; Dr. F. Gagnepain, Museum d'Histoire Naturelle, Paris, France; Professor Ernst Lehmann, University of Tubingen, Germany; Dr. M. J. Sirks, Institut voor Plantenverdiling, Wageningen, Holland; Dr. W. E. de Mol, Lisse, Holland; Erling Kvaale, Norway, Dr. Rudolph Florin, Royal Swedish Museum of Natural History, Stockholm, Sweden; Professor F. Kotowski, College of Agriculture, Warsaw, Poland; Professor W. Paschkevitch, presented by Professor N. Maxomow, Institute of Applied Botany, Leningrad, Russia; Professor Torasaburo Susa, Hokkaido Imperial University, Sapporo, Japan, and Professor Akio Kikuchi, Tottori Agricultural College, Japan.

SCIENTIFIC NOTES AND NEWS

M. Paul Langevin, professor of physics at the Collège de France, has been elected president of the French Association for the Advancement of Science.

The fifth William Thompson Sedgwick Memorial Lecture was given this year at the Marine Biological Laboratory at Woods Hole, Mass., by Professor Thomas Hunt Morgan, of Columbia University, whose subject was "Genetics and the Physiology of Development." The lectureship was established in 1922. Earlier lecturers have included Dr. Edmund B. Wilson, of Columbia University; Dr. William H. Welch, of the Johns Hopkins University; Dr. W. J. V. Osterhout, formerly of Harvard and now of the Rockefeller Institute for Medical Research, and Dr. Charles V. Chapin, superintendent of health, Providence, R. I.

The medal of the American Society of Mechanical Engineers was awarded to Dr. Robert Andrews

Millikan, on June 30, following the dinner at the Palace Hotel, San Francisco. President Abbott introduced Warren H. McBryde, chairman of the San Francisco section and chairman of the local committee of arrangements, who acted as master of ceremonies. Past-president Ira N. Hollis, chairman of the committee on awards, and Past-president William F. Durand presented Dr. Millikan. Dr. Durand made the presentation address in which he outlined the achievements of the medalist as a scientific man and as an engineer. President Abbott bestowed the medal, the highest award of the society, with a simple statement, to which Dr. Millikan responded in equally simple terms, expressing his heartfelt appreciation of the honor. Following introductory remarks by Mr. McBryde, Dr. Millikan made an address on "Atomic Mechanics."

At the close of his address the president of the British Medical Association, Dr. R. G. Hogarth, was asked to present to Sir Humphry Davy Rolleston, regius professor of physics in the University of Cambridge, the association's Gold Medal of Merit and an illuminated address in recognition of his scientific work and of his distinguished services to the profession and to the British Medical Association.

The Messel Memorial Medal was presented to Lord Balfour at the opening meeting in London of the Society of Chemical Industry and Congress of Chemists. Lord Balfour delivered the Messel Memorial Lecture, taking as his subject "The Relation of the State to Science and Industry."

The 1924 first national prize of Argentina for "sciences" has been granted to Dr. Tiburcio Padilla, for his book on electrocardiography. The value of the prize is about $12,000.

We learn from *Nature* that Professor Carl Diener, professor of paleontology in the University of Vienna, has been elected a foreign member of the Geological Society, London. The following have been elected foreign associates of the society: Dr. A. L. Day, of the Geophysical Laboratory, Washington, D. C.; Professor Otto Jækel, professor of geology and paleontology in the University of Greifswald; Professor Maximin Lohest, professor of geology and physical geography in the University of Liège, and Professor Pierre Pruvost, professor of geology and applied mineralogy in the University of Lille.

The University of Liverpool will confer the degree of master of science, *ex officio,* on Mr. Herbert Clifton Chadwick in consideration of meritorious services rendered to the staff and students, and of distinction in zoological research durng the period 1897–1922, when he was curator of the Marine Biological Station at Port Erin, Isle of Man.

The fiftieth anniversary of the scientific career of the Russian physicist, Professor O. D. Khvolson, was celebrated on May 16, at Leningrad, in the auditorium of Leningrad University. The proceedings were opened by Academician Joffe, a student of Professor Khvolson, who declared the meeting open on behalf of the Russian Association of Physicists. Greetings to Professor Khvolson on behalf of the Academy of Sciences were delivered by Professor Oldenburg, who was followed by Professor Fersman, Professor Kamenstchikov and others. In commemoration of the anniversary it was decided to change the name of the University Library into that of Khvolson Library.

Dr. Hanor A. Webb, George Peabody College for Teachers, Nashville, Tennessee, has been elected chairman and Dr. Francis D. Curtis, University High School, University of Michigan, Ann Arbor, Michigan, has been elected secretary of the Science Section of the National Education Association to serve for the year 1926–27.

Sir Berkeley Moynihan (Leeds), has been elected president and Sir Cuthbert Wallace and Mr. Francis J. Steward vice-presidents of the Royal College of Surgeons, for the coming year.

Dr. M. Torino has been appointed president of the National Academy of Medicine of Argentina.

Sir Jagadis C. Bose, founder and director of the Bose Research Institute, Calcutta, who is at present in England lecturing and giving experimental demonstrations on plant stimuli and responses, has been elected president of the Indian Science Congress to be held in Lahore in January next.

At the recent meeting of the British Medical Association, it was agreed to elect John Francis Hall-Edwards, known for his work and sufferings in connection with X-rays, an honorary member in recognition of his services to medicine. The vote was unanimous and with acclamation.

Dr. E. Fischer, professor of anatomy at the University of Freiburg, has been appointed director of the institute for anthropologic research now being organized at Dahlem.

Dr. W. H. Gibson, for the past seven years in charge of the research department of a Belfast linen firm, has been appointed director of research for the Linen Industry Research Association in succession to Dr. J. Vargas Eyre.

Professor Marston Taylor Bogert, senior professor of organic chemistry, Columbia University, has accepted the position of contributing editor of *The American Perfumer and Essential Oil Review.*

Robert M. Davis, statistical editor of *The Electrical World* since 1919, has been promoted to be statistical adviser and consultant of the McGraw-Hill publications. Prior to joining the staff of *The Electrical World,* Mr. Davis was for several years identified with the United States Geological Survey, engaging in engineering and statistical work in connection with water-power development. Gustav F. Wittig, formerly assistant professor of electrical engineering at Yale University, will succeed Mr. Davis.

M. L. Wilson, for the last two years in charge of the division of farm management and costs, Bureau of Agricultural Economics, resigned on July 19 to return to the Montana State College Experiment Station. H. R. Tolley, of the division of farm management and costs, has been appointed his successor.

H. N. Carlson, formerly of the Massachusetts Institute of Technology and Wentworth Institute, is now associated with the R. H. Baker Company, Inc., Cambridge, Mass., as engineer of construction and design.

Dr. Harold S. Palmer, professor of geology in the University of Hawaii, has been granted a sabbatical leave for research in Europe and the South Seas. Otis W. Freeman, of the State Normal School at Cheney, Wash., will be acting professor of geology in the University of Hawaii at Honolulu for the school year of 1926–27.

Professor Ivan C. Shunk, of North Carolina Agricultural College, is spending a ten weeks' period of research in the department of soil microbiology of the New Jersey Agricultural Experiment Station.

Dr. Tage U. H. Ellinger, director of the Department of Live Stock Economics of the International Live Stock Exposition, Chicago, upon nomination by Secretary Jardine, has been invited to represent the United States at the dedicatory exercises and the international professional meeting at the Royal Veterinary and Agricultural College of Denmark, on August 24 to 27. Dr. Ellinger will officially represent the International Live Stock Exposition Association, the University of Chicago, the American Society of Animal Production, the American Farm Economic Association and the Institute of American Meat Packers.

Dr. Jean Charcot sailed on his ship, the *Pourquoi Pas,* from Cherbourg on July 15, on a long research cruise in the Arctic regions. He was accompanied by a number of scientific men.

In addition to the papers listed in Science for July 23 forming the symposium on the relation between pure and applied science to be given before the section of engineering at the Christmas meeting in Philadelphia of the American Association for the Advancement of Science, Dr. Vernon Kellogg, permanent secretary of the National Research Council, will speak on "Biology."

Dr. K. W. Wagner, president of the German department of telegraphs, has been invited to give a series of lectures at the Massachusetts Institute of Technology.

Dr. Arnold Sommerfeld, professor of theoretical physics at the University of Munich, recently made a lecture tour of the British universities of Oxford, Cambridge, Edinburgh and Manchester. His subject was "Atomic Structure."

The Victor Horsley Memorial Lecture of the British Medical Association was delivered on July 9, at the association's headquarters, by Mr. Wilfred Trotter, surgeon to the University College Hospital, on "The Insulation of the Nervous System."

On commemoration day at Glasgow University, tributes were paid to the memory of Sir William Macewen, who occupied the regius chair of surgery for thirty-two years. It was intended that Professor Harvey Cushing should deliver an oration on the life and work of Macewen, but he was unable to go to Scotland. In his absence Archibald Young, successor to Sir William Macewen in the regius chair, gave an oration.

Friends of Professor Luigi Donati have published, through the firm of Zanichelli, a collection of his principal memoirs. The volume was presented to Professor Donati in July, 1925, in celebration of his fortieth anniversary as member of the faculty of the Bologna School of Engineering.

A memorial to Ernst Mach was unveiled in the Rathaus Park in Vienna on June 12. Professor Schlick, who succeeded Mach in his chair at the University of Vienna, made the principal address.

Nature reports the following deaths: Mr. A. G. Charleton, past president of the Institution of Mining and Metallurgy, and author of numerous works on ore-mining and treatment, on July 7, aged sixty-eight years; Mr. W. Temple Franks, lately H.M. Comptroller-General of Patents, Designs and Trade Marks, on July 4, aged sixty-three years; Mr. F. Harrison Glew, a pioneer in the utilization of radium and its salts for the preparation of luminous paint and other purposes, on July 10, aged sixty-eight years; Sir Peter Scott Lang, emeritus professor of mathematics in the United College at the University of St. Andrews, on July 5, aged seventy-five years.

The Journal of the American Medical Association announces the death of Dr. Henseval, professor of hygiene and bacteriology at the University of Ghent.

THE International Congress of Physiology opened a five-day session at Stockholm on August 1 under the presidency of Professor J. E. Johansson. There were 567 delegates in attendance, the United States and Germany sending 100 each, and France and England 40 each.

HAVING attained Disko Island, Greenland, northmost point of its itinerary, the Rawson-MacMillan sub-Arctic expedition of the Field Museum is now sailing southward on the first leg of the homeward journey, according to a radiogram received by the director of the museum. All members of the party were well.

THE New York Academy of Sciences offers a Cressy Morrison Prize of the value of $250 for an essay on the "Interatomic Energy of the Sun." The paper must be presented to the secretary of the academy prior to November 1, 1926.

A LENIN MEMORIAL PRIZE for scientific researches has been founded by decision of the Council of People's Commissaries of USSR. The Lenin Prize will be available for researches in all branches of science, providing that the researches are of considerable practical importance. The award of the prize will be in charge of a committee of experts comprising representatives of the USSR Academy of Sciences, the Ukrainian Academy of Sciences, the educational authorities of Soviet Russia and Ukraine, the Scientific Workers' Professional Union and the Scientists' Welfare Committee, with Professor M. N. Pokrovsky as chairman and O. J. Schmidt as vice-chairman. The prizes will be open only to citizens of USSR.

THE Cambridge University Press has recently undertaken to publish *The British Journal of Experimental Biology*. It is the official medium of publication of the Society for Experimental Biology, but its contributors are not limited to members of this society nor to the universities of Great Britain. The editor is Mr. James Gray, of King's College, Cambridge, with the assistance of Dr. Crew, of Edinburgh, and of eight other biologists representative of the different subjects concerned.

UNIVERSITY AND EDUCATIONAL NOTES

HENRY N. WOLLMAN, a business man of Philadelphia and a graduate of the University of Pennsylvania, has offered as a gift to the university a site comprising 178 acres overlooking Valley Forge Park as a new location for its undergraduate schools. The offer will be considered on behalf of the university board of directors by a committee of five to be appointed by Dr. Charles Custis Harrison.

A TECHNICAL COLLEGE to be known as the General Motors Institute of Technology will be established at Flint, Mich. The new school will absorb the Flint Institute of Technology now scattered throughout the city in small units under the direction of the Industrial Mutual Association. The courses will be conducted on the cooperative plan, with alternate four weeks in the factories and four weeks in the institute.

DR. LEONER MICHAELIS, professor of the applications of physical chemistry to medicine at the University of Berlin, and Dr. Karl Herzfeld, professor of physical chemistry at the University of Munich, have been called to the Johns Hopkins University.

DR. OSKAR SCHMEIDER, lecturer in geography at the University at Bonn, has been appointed associate professor of geography at the University of California.

PROFESSOR CLARENCE VICTOR CHRISTIE, associate professor of electrical engineering at McGill University, Montreal, has succeeded the late Professor L. A. Herdt as Macdonald professor of electrical engineering and head of the department of electrical engineering of the university.

A. C. BAILEY, who received his master's degree this summer from Iowa State College (Ames), goes to the Chulalankarana University at Bangkok, Siam. He will have charge of the development of the department of physics at the Government University under a grant from the Rockefeller Foundation.

DR. JOSEPH H. SIMONS, head of the department of chemistry of the University of Porto Rico, will join the staff of the department of chemistry at Northwestern University.

G. RICHARD BURNS has resigned his position as research chemist in the dyestuffs division of the du Pont Company to become instructor in chemistry at Yale University next year.

RECENT appointments of fellows in medicine of the National Research Council, to academic positions, are as follows, the department in which they have been working being given in italics: Barry J. Anson, *Dr. F. T. Lewis, Harvard,* instructor in anatomy, Northwestern University Medical School; Sydney W. Britton, *Dr. W. B. Cannon, Harvard,* associate in physiology, Johns Hopkins; W. V. Cone, *Dr. J. W. Jobling, Columbia,* department of surgery, College of

Physicians and Surgeons, Columbia University; Benjamin Freeman, *Dr. A. N. Richards, Pennsylvania,* instructor in biochemistry, Western Reserve University; Thomas P. Hughes, *Dr. Hans Zinsser, Harvard,* assistant in bacteriology, Rockefeller Institute; Moses L. Isaacs, *Dr. Gay, Columbia,* department of Public Health, College of Physicians and Surgeons, Columbia University; James A. Kennedy, *Dr. Hans Zinsser, Harvard,* instructor in bacteriology, University of Rochester; E. Beatrice Carrier Seegal, *Dr. Wolbach, Harvard,* pathologist, Long Island Hospital, Boston; Fred W. Stewart, *Dr. Mallory, Boston City Hospital,* Rockefeller Institute for Medical Research; Harry B. van Dyke, *Dr. Cushny, Edinburgh, and Dr. Trendelenberg, Freiburg,* associate professor in pharmacology, University of Chicago.

Dr. H. Harold Scott has been appointed lecturer on tropical diseases at the Westminster Hospital Medical School. Dr. Scott, who formerly held the appointment of government bacteriologist, Jamaica, and was afterwards government bacteriologist and pathologist, Hong-Kong, is now Milner Research Fellow in comparative pathology at the London School of Hygiene and Tropical Medicine and pathologist to the Zoological Society of London.

DISCUSSION

THE ENGLISH TRANSLATION OF DE REVOLUTIONIBUS ORBIUM COELESTIUM

Referring to the communication by Mr. Drew Bond, published in Science, June 25, relative to the need of an English translation of the immortal work of Copernicus, *"De Revolutionibus Orbium Coelestium,"* Libri VI, 1543, the following may be of interest to others as well.

In *Nature* of December 16, 1920, page 515, there appeared a short statement that Professor J. F. Dobson, professor of Greek at the University of Bristol, and Dr. S. Brodetsky, lecturer in applied mathematics at the University of Leeds, have nearly completed their English translation of this epoch-making book. This translation will be accompanied by a life of Copernicus with some account of his influence, and the history of the hypothesis connected with his name.

Being greatly interested in this historic work, and having had occasion to refer to a German edition—the want of an English translation seemed propitious from a librarian's point of view—I therefore wrote these gentlemen stating how needful and appreciative their work would be.

Last December Mr. W. L. Cooper, librarian of the University of Bristol, wrote me that Professor Dobson was revising the proof which would be ready for publication at the end of the year (1925). He also stated that he was receiving valuable assistance from Dr. Charles Singer, of the University of London, in the references and notes requiring an intimate knowledge of medieval science. The Oxford Press will undertake the publication of this work.

I am sure that the English translation of this most important work in the history of science, since it established the true beginning of modern astronomy, will be received with delight by the historians of science as well as by those whose business it is to know books. It may also be of interest to know that there are three other copies of the first edition of Copernicus in the United States besides the one in the New York Public Library, namely, Boston Athenaeum Library, Massachusetts Institute of Technology and Harvard University. There was another copy in the possession of the late Professor Louis Derr, of the Massachusetts Institute of Technology.

The original edition of this work is now extremely rare and commands a correspondingly high price. And the history of the second and third editions are now attracting the attention of bibliographers and historians.

The second edition was published in Basile 1566 and is almost as rare as the first of 1543. This edition is the first containing the account by Joachim Rheticus, the distinguished student of Copernicus, under whom he studied from 1539 to 1541. It was he who first assumed the earth's rotation as a fact, whereas Copernicus had treated it only as a hypothesis.

The third and last edition in the original Latin, by Nicolai Mulerii, professor in the University of Groningen, was published in Amsterdam in 1617. This edition was the first containing explanatory notes, and it was noteworthy for the correctness of the text, the lack of which was a fault in the two preceding editions. This edition was reprinted in 1640.

Upon the occasion of the four hundredth anniversary of the birth of Copernicus, celebrated at Thorn in 1873, a very fine edition was issued, printed anew from the original manuscripts, preserved in the Nostiz Library of Thorn. Two copies of this work are in the Library of Congress.

The German edition, "Über die Kreisbewegungen der Weltkörper," übersetzt und mit Anmerkungen von C. L. Menzzer, durchgesehen und mit einem "Vorwort von Moritz Cantor," was published in Thorn in 1879. This is the only translation into a modern language, besides a Polish edition. The German and the second and third editions are in the private library of the writer.

The English translation of "De Revolutionibus Orbium Coelestium" will therefore be an appropriate scholarly contribution to the history of science and

will serve to perpetuate the four hundred and fiftieth anniversary of the birth of the great author, Nicolaus Copernicus.

Frederick E. Brasch

Library of Congress,
Smithsonian Division

FLUORIDES VERSUS FLUOSILICATES AS INSECTICIDES

Under the above caption, Mr. R. C. Roark made reference to certain preliminary contributions[1] by the writer relative to the insecticidal value of fluosilicates in the control of the bean beetle and other insects. Mr. Roark first made the point that "there is nothing new in the use of sodium fluosilicate as an insecticide. Its use for that purpose was described nearly thirty years ago by Higbee (English Patent No. 8236, May 23, 1896)." He then advanced chemical equations to demonstrate the contention that the fluosilicates would break down into fluorides in an aqueous system.

From the foregoing statement, one would infer that Mr. Roark was under the impression that the writer had claimed to have discovered the insecticidal properties of sodium fluosilicate.

The writer did not make such a claim, nor did he intend to convey this impression in any of the three articles[1] cited by Roark. Neither was it intended so to do in bulletin 131, of the University of Tennessee Agricultural Experiment Station, which reported experimental results from a number of fluorine compounds, including sodium fluosilicate, cryolite, calcium fluosilicate, calcium fluoride and certain combinations not in general usage. This, our first contribution, was not cited by Mr. Roark and probably had not been seen by him.

From the inception of the experiments, attention was focused on the element *fluorine,* because of its known efficiency in the control of certain pests. After investigation as to methods of manufacture of the fluorides the thought came that the cheaper, raw product, sodium fluosilicate (Na_2SiF_6), might prove of value. Diligent search of the *scientific* literature failed to disclose a report on the use of this material as a protective agent for plants. Later, however, an obscure British patent of nearly thirty years' standing was brought to our attention. This patent was primarily intended to cover the use of *solutions* in outdoor practice. In our investigations, which were carried out without the benefit of knowledge concerning Higbee's patent, and with special reference to the control of the bean beetle, we adopted the idea of dilution by a solid carrier to minimize or eliminate plant injury. In so far as we have been able to ascertain, this constitutes the first scientifically planned experiment with the fluosilicates for the control of the bean beetle by dusting.

In substance, our reports have been based upon findings obtained by practical field tests and under scientific control. No attempt was made to explain the chemistry responsible for the lethal effect produced in the field. On the other hand, the contribution by Mr. Roark embodies, in the main, a hypothetical discussion of the chemical factors involved, with promise of a report upon tests made to establish the insecticidal value of certain related fluoride products of minimum solubility.

S. Marcovitch

University of Tennessee

[1] *Ind. Eng. Chem.*, 16, 1249, 1924; Science, 61, 22, 1925; *Jour. Econ. Entomology,* 18, 122, 1925.

COMMENTS ON "VACUOLES"

The article on "The Origin of Vacuoles" in the issue of Science for April 30 awakens interesting associations. About 1849,[1] Carl Nageli described certain plasmic structures of plant cells, which he named "Utricles" and which included plasmic vacuoles. Unaware at the time of the observations by Nageli, the writer in 1915[2] made a study of certain plant cell inclusions, which were described under the name "sphaerocytes," and which included in part the Utricles of Nageli, the "Zellenreste" of various authors and the "Vacuoles" of Lloyd and Scarth. An article on vacuoles appeared about 1897, but thus far the writer has not been able to find the reference again, although his memory suggests the Berichte der deutschen botanischen Gesellschaft. Vacuolization of cell plasm is well known. Chlorophyll grains frequently become vacuolized, as in beet blight. Vacuolization should, however, not be confused with plasmic vacuoles nor with the sphaerocytes mentioned. Certain sphaerocytes, notably the nucleosphaerocytes, possess a remarkable vitality, having been kept alive in hanging drops for over eighteen months, showing marked growth and also nuclear increase (not septation of the sphaerocytes, however). It is much to be regretted that these structures have not received the attention of researchers in biology and botany.

Albert Schneider

North Pacific College of Oregon

[1] "On the Utricular Structure of the Contents of Cells," Reports and Papers, Botany, Ray Society, London, 1849.

[2] "Die Blasenzellen (Sphaerocyten) der Pflanzen und ihre Bedeutung zur Erklärung Neoplasmischer Bildungen." *Deutsch-Amerikanische Apotheker-Zeitung,* November, 1915; "The Sphaerocytes of Plants and Their Possible Significance in Plant Growth and in Neoplasmic Formations," *Pacific Pharmacist,* November, 1915.

SCIENTIFIC BOOKS

Genetic Studies of Genius. Vol. I, "Mental and Physical Traits of a Thousand Gifted Children." By Louis M. Terman, et al., XV + 648 pp., 35 figures, Stanford University Press, 1925.

This book reports the results of an elaborate study of approximately one thousand bright California school children. That the flames of genius are kindling in the hearts or heads of even a considerable proportion of this group of young Californians, as the main title of the book would seem to suggest, is an implication which the rest of the country will properly take with a grain of salt. In fact, an examination of the methods of selection of these children offers no guarantee that any potential geniuses are included in the study. It probably still takes a genius to catch a genius, and the intelligence test, which was the ultimate basis of the selection of this group, has by no means as yet attained to this eminence. The present intelligence tests are designed to give an estimate of the general level or average of an individual's abilities; they take account of specialized abilities only as they affect the average, and they unfortunately, as it seems to the reviewer, prefer for the most part a *reactive* rather than a *creative* type of mind. The ordinary conception of genius is quite the opposite of this: an unusual equipment of rather specialized or "one-sided" abilities with the *sine qua non* of creation rather than of reaction. To the reviewer's mind, therefore, this book makes an important contribution to our knowledge of the mental and physical characteristics of very bright or clever even, rather than of necessarily gifted, school children.

The purpose of the research was to locate subjects of a degree of brightness well within the top one per cent. of the school population. The survey was limited to certain of the large cities of California. The main experimental group of 644 children was selected from six cities; the proportion selected was one for each 258 individuals in the canvass. The group is therefore, in the first place chiefly urban in character. The children were selected first by the nomination of teachers, and secondly by the intelligence test. The range of intelligence quotients of the main experimental group thus selected was from 130 to 190. Somewhat over one half of this group had intelligence quotients between 140 and 149, inclusive. In addition to nominating the three brightest children in their classes the teachers were also asked to name the youngest child. An interesting finding in this connection is that nomination as youngest yielded more subjects who would otherwise have been missed than any other kind of nomination, about 20 per cent. of the total nominated group. In other words, as the author notes, "if one would identify the brightest child in a class of thirty to fifty pupils it is better to consult the birth record than to ask the teacher's opinion."

Of the children in the main experimental group 54.7 per cent. were boys and 47.3 were girls, giving a sex ratio of 1.21. This ratio is higher than that of the comparable school population in the cities covered by the survey, which is 1.05. Various explanations of this finding are suggested by the author, including the possibly greater variability of the male and the differentiated death-rate of embryos.

Reliable data on the relative frequency of the different racial stock represented in the cities covered by the survey were not available. About 10 per cent. of the experimental group were found to be of Jewish extraction, which, it is estimated, is about twice that to be expected from the proportion of Jews in the population of the cities covered. The largest percentage of the group were of British extraction, the percentage of Scotch being especially high. The percentage of Latin blood was very low. The Chinese and Japanese children were not included in the study.

Over 80 per cent. of the fathers of the children of this group came from the professional or semi-professional classes; 12 per cent. of them were classified as skilled laborers; between 6 and 7 per cent. as semi-skilled and only about one tenth of one per cent. as common laborers. The average schooling of the parents was approximately twelve grades, which is about twice that of the average adult in the population at large. The schooling of even the grandparents of these children was approximately ten grades. One fourth of the subjects had at least one parent who was a college graduate. Unfavorable home conditions were found in only about 8 per cent. of this group, as compared with about 24 per cent. of the control group. Rating by the Whittier Scale for home grading substantiated this finding in regard to the superiority of the homes of these children. Nearly half of the children had learned to read before starting in school and by seven years of age had read more books than unselected children of fifteen years. Despite these evidences of the possible influences of cultured homes the author concludes his chapter on racial and social origins with the remark that it offers considerable indirect evidence that the heredity of these children is much superior to that of the average individual. The author also believes that his data on intellectually superior relatives, "fragmentary as they are," give considerable support to Galton's theory of the hereditary nature of genius. A further argument for the greater potency of heredity over environment in explaining the intellectual superiority of these children is found in the preponderance of first-born gifted children in families of two or more. To state

the conclusion in the author's own words: "The fact that superiority of the first born registers in childhood as clearly as in the achievement of adult life suggests that the causes are to be sought in native endowment rather than in environment and education." It is, however, not at all clear why it is better thus to assume that such vigorous heredity so readily peters out than to assume that, for various reasons, parents may do more for their first born, in the way of intellectual stimulation and advancement, than for their subsequent born.

An investigation of the economic status of 170 representative families of the group found a median income of $3,333. Thirty-five per cent. of these families reported an income below $2,500, which is about equal to that of the average skilled laborer; only 17 per cent. reported an income above $7,500 and 4 per cent. above $12,000. This finding would seem to indicate that gifted children and wealth are not associated, whereas the biographies of men of genius often indicate that the leisure which money *can* provide has made the fruition of genius possible.

One possibility which may bear on these various arguments is, as it seems to the reviewer, this: that the tests and teachers alike have selected as gifted or as geniuses those who as a result of their early training and influences at home have acquired scholastic interests or academic turns of mind and have overlooked those who have not.

Anthropometric measurements as well as records of the health of these children showed that the gifted as a whole were superior with respect to physical size and condition to the children of the control groups. Pubescence appears somewhat earlier in the gifted boy than among unselected boys—although this conclusion is tentative because of the small number of gifted boys in the study above twelve years of age—and menstruation appears earlier in gifted girls than in the girls of the control group. Eighty-five per cent. of the gifted children were found to be accelerated and not one to be retarded in school. The average progress quotient of the group was equal to 114, which means that the average gifted child is accelerated 14 per cent. of his chronological age.

The contrast between grade location and the performance in tests of school accompaniment, namely the Stanford Achievement tests, is striking. The superiority of the gifted amounts in most cases to from three to four times the standard deviation of the unselected group. In knowledge of the subject-matter of instruction gifted children are at a point 40 per cent. above their chronological ages, although, as noted, they are held back to a grade location only 14 per cent. beyond the norm of their chronological ages. Chiefly on this account, doubtless, their accomplishment quotients do not equal their intelligence quotients; the A. Q.'s tend to run only from three fourths to four fifths as far above the average as did the I. Q.'s.

The gifted children showed no greater specialization of abilities in school subjects than did the average child, a finding which may possibly be taken as another indication that such geniuses as the study has discovered are concealed as to their characteristics by the mass of simply bright children from whom they have not been differentiated. The author of this section of the book, Professor James C. DeVoss, also finds evidence of the relatively greater potency of heredity over environment in the fact that there is a lack of parallelism in the development of abilities to deal with school subjects which is too great to be accounted for, as he thinks, by the differences in training.

Remaining chapters of the book deal with the rating of the scholastic, occupational, play, reading and other intellectual, social and "activity" interests as well as of the character and personality traits, in all of which the gifted children are for the most part superior to the average child. These chapters provide a wealth of information which the specialist in the various fields may be able to relate to his special problems, and which the lay readers, including those especially who may wish to compare their own offspring in these respects with the subjects of the study, will find interesting although perhaps not particularly illuminating.

Walter F. Dearborn

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

ON THE RETENTION OF A BALL BY A VERTICAL WATER JET

There is a strangely wide-spread belief that the quasi-stable support of a light ball in a vertical water jet is due to forces that may be accounted for by the principle of Bernoulli. The experiment described below shows that at least 98 per cent., if not the whole of these forces, comes from the change in momentum of the water as its direction is altered by adhesion as it passes over the curved surface of the wet ball.

Fig. 1*a* and *b* show a light wire frame supported on needle points so that it may swing in one plane only. Near its lower end is carried a wooden ball *B* (about 7 gm diam., 2.6 cm) on which the jet *J* (Fig. 1*b*) may be adjusted to impinge. Just behind the ball are two light metal plates *CC* that may be separated, as shown in Fig. 1*a*, to let the deflected water pass freely through the frame or that may be

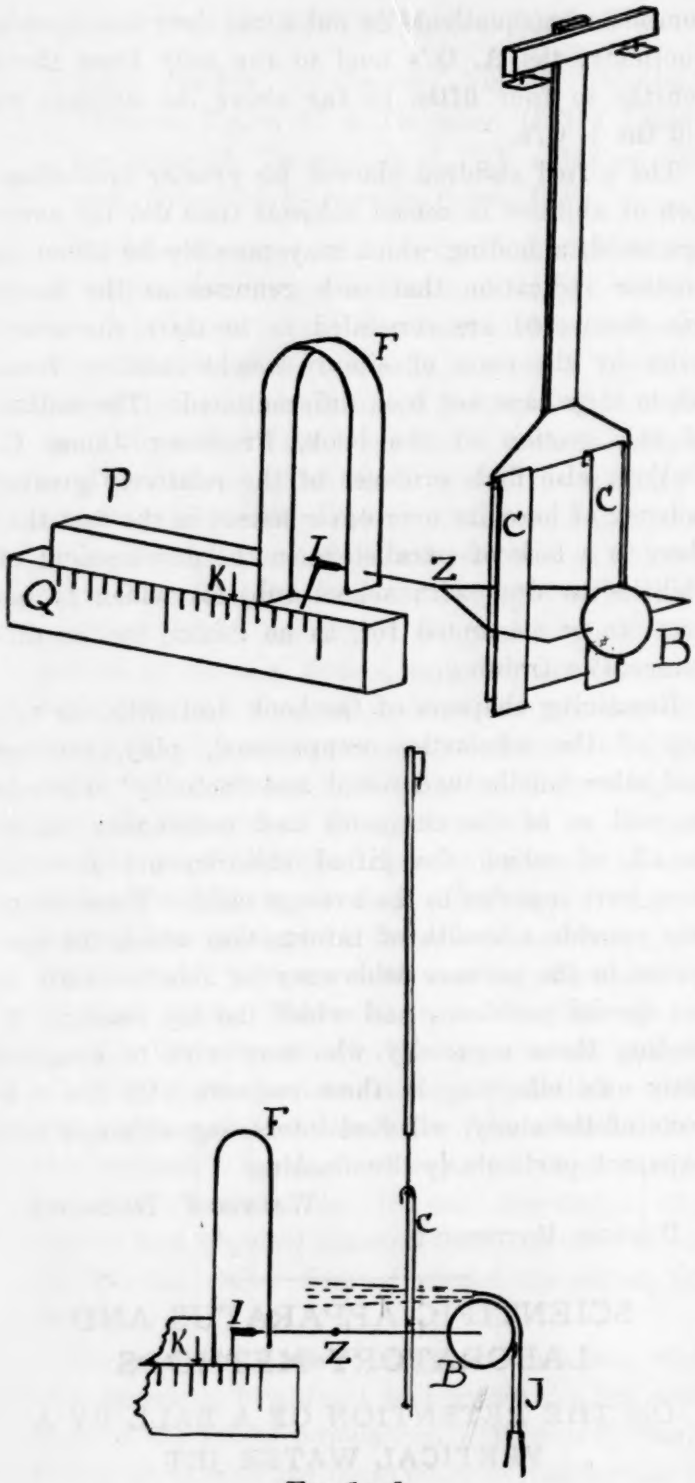

FIG. 1*a*, *b*

pushed together to receive the full impact of the deflected jet. The horizontal forces exerted on the ball by the jet, for any condition of impact, may be balanced by the force exerted by the deformation of a light steel spring *F*. The spring is attached to the wire frame by the yoke and straight wire *Z*, the latter passing through a hole in the end of the spring and terminating in an index *I*. The other end of the spring is carried by a block *P* that with its index *K*. may be slid back and forth over the scale on the bar *Q*.

When no jet strikes the ball a slight tapping on *P* permits the wire *Z* to move to or fro in the hole until the index *I* comes to rest at some point on the scale which, when once noted, may be used to determine the equilibrium position of the frame under gravity alone. The block *P* is then moved back along the scale to the extreme position at which it *does not displace the index I*, then the reading of index *K* gives the extreme position of no strain on the spring. Now when the jet is allowed to strike the ball on the side remote from the spring the sphere is drawn into the jet, deforming the spring. *P* is now moved back until the index *I* returns to its zero position. The linear displacement required to do this, together with the determined stiffness of the spring, gives at once the total horizontal force exerted by the jet on the ball.

The following facts were established: When the ball is in the jet at the level at which its weight is just balanced by the vertical impact of the water, the plates *CC* being drawn back to allow the free passage of the water through the frame, it is acted on by a horizontal force towards the axis of the jet that depends on the point of impact. This force is, of course, zero in the symmetrical position on the axis of the jet, and as the point of impact is taken farther and farther from the vertical diameter of the ball the force increases to a maximum of about the weight of the ball *when the ball is allowed to spin freely on its own horizontal axis*, but to a maximum of only about 60 per cent. of this when it is clamped so that it may not spin. This difference is chiefly due to the frictional diminution of speed in the jet in the second case, as it passes over the surface of the ball, that is, in the latter case the momentum carried away horizontally is less than in the first. When the plates *CC* were moved together so as to receive the full impact of the deflected water the slightest observable displacement of *K* from its zero position is accompanied by a corresponding displacement of *I*, indicating that the force exerted on the ball by the jet is exactly compensated by the impact of the deflected water on the plates. Of course if the speed of the jet be too great some of the water may miss the plates in which case the horizontal momentum that is carried by the escaping water has its counterpart in a reaction that pulls the ball farther into the jet. As the displacement of *K* necessary to balance the maximum horizontal force on the ball was about 20 mm (corresponding to about 7 gm-wt.) and as a displacement of less than 0.5 mm. could be read with ease, it is concluded that at least 98 per cent. of the forces involved come from the change of momentum of the water and that if there be any force to be accounted for by the principle of Bernoulli it is a very small quantity, if indeed it exist at all.

One or two other points in this connection may be of interest. Fig. 2 shows an open end manometer *L*

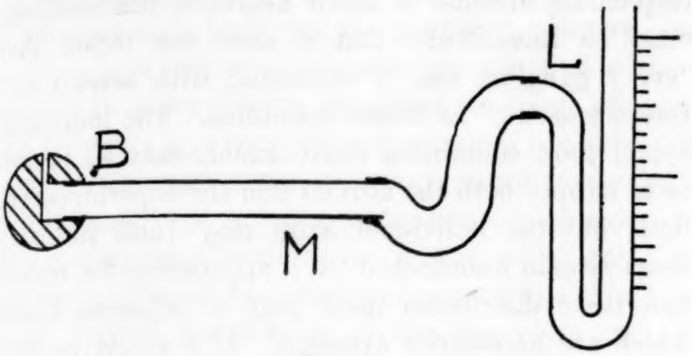

FIG. 2

connected by a bit of rubber tubing to a glass tube M which passes axially into a wooden ball B into which it is cemented. Connecting the tube M with the surface of the ball is a small hole (1 mm diam.) that runs radially in the sphere and at right angles to the axis of M. A ball similar to B is placed in a vertical water jet fed by the constant head from a large wall pocket. When this has found its level of quasi-equilibrium it is replaced in that position by the ball of Fig. 2, which is clamped rigidly in place. Now we may measure the pressure exerted on the sphere at any point simply by adjusting the ball so that the orifice in its surface is at the required spot. It is necessary to see that the whole tube from the orifice in the surface to the level of the water in the open arm of L be continuously full of water—no air bubbles being present that by their surface tension effects might mask the changes of pressure sought. It is also necessary, when one obtains the zero reading of L—*i.e.*, the level of the free surface of L when no jet strikes the ball—that water be slowly dropped on top of the ball B and allowed to run down over the orifice so that the surface of the water at the opening may have the curvature of the ball, as it has when the jet spreads over it. The stopping and starting of the jet would set up disturbances in the flow of the water from the wall reservoir, so it is best to keep the jet running continuously and to intercept it when necessary by a baffle plate between the nozzle and the ball. So after determining the zero reading at L one merely removes the baffle plate and observes the excess or defect of the pressure at the orifice from that of the atmosphere without the necessity of waiting for the flow to become steady again. Fig. 3 shows the order of values obtained with a jet of 3 mm diam., impinging on a ball of 2.6 cm diam. (about 7 gm) at a point where it is balanced in the jet (the velocity head being 75 cm). The pressure differences are given in mm of water *less* than atmospheric pressure. The unfeathered arrows indicate the point of impact of the jet. The -3 at the top of one diagram shows a pressure of 3 mm *greater* than atmospheric caused by water that in this symmetrical case fell back on top of the ball. The feathered arrows in the second case indicate the direction on which most of the water left the sphere. These observations are of value only in indicating the *order* of pressure differences set up. Calculations of pressures to be expected from the change of momentum as the water passes over the curved surface are easily made on the assumption that there is no splash and that the water passes uniformly over the surface of the sphere; but these have little value for comparison with experiment, as neither of these assumptions is even approximately fulfilled in the experimental case.

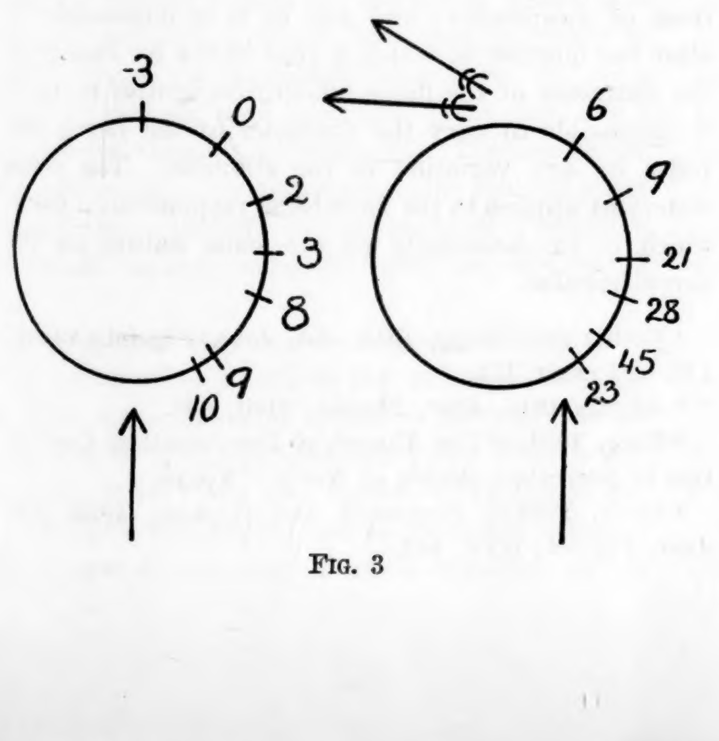

FIG. 3

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SPECIAL ARTICLES

THE BASIS OF REFLEX COORDINATION

IN some recent papers Weiss[1, 2] has proposed a new hypothesis for explaining reflex coordination, which invokes the conception of qualitative differences in excitation of nerve fibers. The nature of the reflex coordination involved is best illustrated by the fact that in movements of progression all flexor muscles contract together, while the extensors relax, and *vice versa*. Weiss contends that a single motor neurone, after branching, innervates muscle fibers which are widely distributed and may be components of antagonistic muscle groups. In order to reconcile this contention with the orderly coordination of the muscles, he assumes that the motor neurone may conduct "various specific forms of excitation, to each of which certain particular muscles are attuned, owing to their specific make-up." He suggests something analogous

[1] Weiss, 1924, Arch. f. mikroscop. Anat. u. Entwicklungsmech., cii, 635.

[2] Weiss, 1926, *Jour. Comp. Neurol.*, xl, 241.

to resonance and insists that the distribution of orderly motor effects must be based on "the specific accord between the end-organ and the excitation form."

This conception of tuning of muscles to a specific form of excitation involves such a radical and fundamental departure from the doctrines now held as to the functional properties of nerve and muscle, and if substantiated would revolutionize the entire physiology of the nervous system so profoundly that it should be subjected to the most careful scrutiny. Detwiler[3] has raised objections to the proposed hypothesis, but Weiss was not convinced of their validity, for he has insisted with increased emphasis upon the necessity of his view.[2]

The basis of Weiss's theory seems to be his conviction that the branching of motor axons involves their distribution to antagonistic muscle fibers. Both he and Detwiler have shown the remarkable fact that in amphibians a supernumerary limb transplanted close to a normal limb will receive an innervation which coordinates its muscular action with that of the adjacent normal limb. Weiss denies the possibility of specificity "involved in the control of the direction of the nerve-fiber branches in their outgrowth toward the periphery" and concludes that their distribution among the muscles is altogether a matter of chance; thus he is forced to the conclusion that coordination can only be explained by "tuning" of the muscle.

It is indeed difficult to conceive of any explanation of coordination other than the two following interpretations contrasted by Weiss. (a) If coordination depends on the central distribution of nerve impulses, then the functionally indivisible conducting path (presumably the motor neurone) must innervate only those muscle fibers which are to work together. (b) If a single motor neurone, through branching, innervates antagonistic muscle fibers which do not contract together(as Weiss contends), then the muscle must have some power to select a special component in excitation, in order to account for the observed coordination, unless, as seems improbable, the functional unit is not the neurone, but the neurofibril.

Weiss furnishes neither proof nor evidence for his assertion that a single motor neurone may innervate antagonistic muscle fibers. The only reason for that conclusion appears to be the fact that when a supernumerary limb is added, an increased number of muscle fibers is innervated from the same number of ganglion cells that normally innervated but a single limb. This implies increased branching of neurones. It is well known that a single motor neurone normally innervates several muscle fibers, and if there is an increase in the number of muscle fibers without a corresponding increase in motor neurones, this condition must be intensified. But it does not follow that "every ganglion cell is connected with several different muscles," as Weiss maintains. The individual spinal root, containing many axons, may so branch as to supply both the normal and the supernumerary limb, but the individual axon may (and probably does) remain unbranched till it approaches the muscle and there distributes itself only to adjacent fibers, which are necessarily synergic. If a single neurone branched in such a way that it innervated both limbs, an amazingly high degree of specificity would be required to direct the growing axons to homologous muscle groups in each. But the proof that there is any such remote distribution of branches does not exist. There is no need, therefore, of accepting that assumption.

[3] Detwiler, 1925, *Jour. Comp. Neurol.*, xxxviii, 461.

Let us consider the physiological demands of the theory proposed by Weiss. The ability of muscle fibers to respond selectively to certain components in the "excitation" broadcast over a branching neurone would require either the power of nerve to conduct qualitatively different impulses or a property of resonance in muscle to a special frequency —a resonance so selective that higher or lower frequencies would fail to excite it.

Let us examine the possibility of varying the quality of a nerve impulse. Experiments have shown that whatever form of stimulus is applied to a motor nerve—electrical, mechanical or reflex—the response appears to be identical in character, as far as objective criteria can reveal it.[4] Furthermore, not only the character, but the size of the nerve impulse in the conducting unit, has been shown to be independent of the strength of stimulus.[5, 6, 7] It is well established that the energy of the impulse comes from the nerve fiber and not from the stimulus; the latter releases energy from an unstable system, and the response is thus analogous to an explosion. This fact puts the impulse in the class (dynamically) with a fuse or train of gunpowder; and just as it is impossible to alter the manner in which a fuse burns by changing the character of the flame which first ignites it, so it is impossible to vary the character of the nerve impulse by any variation in the stimulus. The same statement applies to the functional response of muscle, which is fundamentally of the same nature as the nerve impulse.

[4] Forbes and Gregg, 1915, *Am. Jour. Physiol.*, xxxvii, 118, and xxxix, 172.

[5] Adrian, 1914, *Jour. Physiol.*, xlvii, 460.

[6] Kato, 1924, ''The Theory of Decrementless Conduction in Narcotised Region of Nerve.'' Tokyo.

[7] Davis, Forbes, Brunswick and Hopkins, 1926, *Am. Jour. Physiol.*, lxxvi, 448.

Since we can rule out qualitative differences in the nerve impulses as a basis for the proposed selective power of muscle, we must consider the question of frequency. It is possible to design an electrical apparatus in which a current flowing through a single wire traverses several resonant devices tuned to different frequencies. It is then possible to send through the wire a complex alternating current in which any desired combination of frequencies is present and thus make any desired combination of the resonators respond. But if we try to liken the neuromuscular mechanism to such a system, we encounter at the outset the difficulty that the nerve fiber is not a passive conductor like the wire, in which alternating currents of an unlimited number of frequencies can be transmitted simultaneously; it is more like a machine gun which can only be discharged with one frequency at a time, and a definitely limited frequency at that. The refractory phase in nerve, during which there must be recovery from one response before another can occur, is a well-known property of the nerve impulse, which Adrian[5] has shown to be inseparably associated with its all-or-none character. This refractory period sets a definite limit to the frequency of nerve impulses—in the case of mammalian motor nerves, about six hundred per second. It is obvious that in view of the all-or-none character of the response, it would be impossible to superimpose a second impulse frequency upon a nerve already responding with a frequency near its limit, and thus to obtain two simultaneous frequencies, as is done with alternating currents in a wire.

As to resonance in muscle, the same general principles apply. Underlying a sustained muscular contraction there are separate functional responses, which can be revealed by recording the electrical action currents. The frequency of these responses is limited in muscle, as in nerve, by the refractory period, which varies with temperature. Normally in mammalian muscles the upper limit is about four hundred per second or less. If time enough between stimuli is allowed for recovery from the refractory phase, it is as easy to stimulate a muscle with one frequency as another. Therefore a muscle can have no more tendency to respond at a particular frequency, like a resonant body, than a magazine rifle. The muscle can not respond with a frequency above the limit imposed by the refractory period. Below that limit it responds to the stimuli as they come, provided they are strong enough.

It is clear then that muscle response belongs to a class of phenomena to which the principle of resonance does not apply and in which there can be no such tuning to a special frequency, as Weiss's hypothesis requires. We are, therefore, forced to accept Detwiler's conclusion that coordination depends on the central distribution of nerve impulses, as has been generally supposed, and not on peripheral selection.

Weiss, in his answer to Detwiler, states that "the all-or-none law holds good only in electrophysiology," and does not apply in normal reflex nervous activity. In support of this proposition he cites Sherrington's emphasis on the differences in the results of artificial and natural stimuli. Sherrington, in dealing with this subject, has described differences which are explicable on the basis of anatomical distribution and sequence in time of the individual impulses in the conducting units; but he has brought out no facts which are incompatible with the view that the underlying unit response is always the same in kind and obeys the all-or-none law. Indeed, Sherrington has recognized the validity of this law in the following words: "All or nothing as a principle of nerve-fiber response seems to me, as to you, established. It must appear as a new datum for whatever schemata we offer of central mechanisms."[8] Thus the statement that the all-or-none law only applies to electrophysiology is altogether unwarranted and is in no way supported by Sherrington's writings. Indeed the "all-or-none" law is explicitly recognized and woven into the fabric of his more recent discussions.[9]

Since the nature of the functional response of nerve and muscle renders Weiss's theory of muscle tuning untenable, we must seek another explanation for the striking fact that almost as soon as the muscles are innervated, the normal and supernumerary limbs exhibit "homologous function"; that is, corresponding muscles in both limbs contract in unison. The explanation may perhaps be found in the proprioceptive impulses. Sherrington has shown the important rôle played by the nerves of muscle sense in coordinating limb reflexes.[10, 11] Detwiler and Weiss have both shown that homologous function only appears when the transplanted limb is innervated from the proper level of the spinal cord. Apparently only those motor neurones which lie at this level can acquire the capacity for this coordination. Given this capacity in the neurones, it is altogether conceivable that the proprioceptive impulses, set up when the muscles begin to contract, initiate the necessary organization of the spinal centers whereby the motor neurones are soon enabled to coordinate the limb movements in the remarkable manner that has been experimentally observed.

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[8] Extract from letter; see Science, 1916, xliv, 809.

[9] Sherrington, 1925, Proc. Roy. Soc., xcvii, 519.

[10] Sherrington, 1915, *Brain*, xxxviii, 203.

[11] Liddell and Sherrington, 1924, Proc. Roy. Soc., xcvi, 212; 1925, *ibid.*, xcvii, 267.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE MILLS COLLEGE MEETING OF THE PACIFIC DIVISION

Western Society of Naturalists

(A. G. Vestal, *Acting Secretary*)

On Thursday morning, a symposium was held on "The Value of Biology to Civilization." Each speaker presented aspects of the situation which were novel to his hearers. Dr. C. A. Kofoid described the value to culture of a knowledge of plants and animals, as a basis for development of art, and as an increasing enrichment of the art of living. Dr. R. C. Miller stressed the desirability of sympathetic liaison between "pure" and "applied" biological science. Dr. H. S. Reed presented the value of biology to economic life as illustrated by food plants. An incidental point brought out is that certain ancient peoples showed much greater acumen than we have thought in selecting and improving useful varieties. A not too immediately hopeful view of the problems of race-improvement and population was presented by Dr. F. B. Sumner. The difficulties are in determining how to apply biological knowledge already possessed.

The afternoon was devoted to a joint meeting with the Ecological Society of America. Joseph Grinnell, in an account of geographic distribution and variation in both Upper and Lower California, showed how numerous series of bird species or varieties exhibit degrees of morphological difference which are roughly proportional to the distances separating them. A paper by W. E. Allen emphasized the limitations of our ways of finding out essential features in the life of marine organisms, and the need of continuity, in space and in time, of investigation of life in the sea as the only means of offsetting these difficulties. G. P. Rixford described the possibility of growing the avocado in certain foothill areas in central California. E. N. Munns advocated a broad biological viewpoint from which to regard problems of forestry, inasmuch as the forest is a very inclusive biological community of very many kinds of plants and animals, all interacting upon one another in most far-reaching ways, and therefore all and together requiring careful study before economic policies can best be formulated.

American Phytopathological Society—Pacific Division

(B. A. Rudolph, *secretary*)

The Pacific Division of the American Phytopathological Society meeting at Mills College, California, June 16 to 19, elected the following officers for the year 1926–1927:

W. S. Ballard, President.
D. G. Milbrath, Vice-President.
B. A. Rudolph, Secretary-Treasurer.
W. T. Horne, Councillor.

Eleven papers were presented, and there were discussions with leaders as follows:

Ecological Aspects of Pathological Problems in the Arid West, M. Shapovalov.

Plant Disease Survey, R. J. Haskell.

The Nature of the Contagium in Virus Diseases of Plants, T. E. Rawlins.

Among visiting members of the parent society were Drs. R. J. Haskell, in charge Plant Disease Survey, U. S. D. A., and H. B. Humphrey, chief, Cereal Disease Investigations, U. S. D. A., both of whom gave delightfully informal talks on the immediate work being done in their respective offices.

Professor R. E. Smith's paper, "Transpiration as a Pathological Factor," a digest of the literature covering the multitude of vague and indefinite diseases so frequently associated with defective transpiration, was one of the most appreciated of all. The tedious work of assembling in a comprehensible résumé the vast data and numerous theories relative to the subject received many warm expressions of approval.

Dr. H. J. Weber's informal account of the citrus industry of South Africa was not only graphically and charmingly told, but it covered in detail many technical phases of the more important problems met with in that country.

Papers by M. Shapovalov, T. E. Rawlins, O. A. Plunkett, Wm. T. Horne, H. N. Hansen and W. W. Mackie were enthusiastically received. Covering widely dissociated fields of investigation each of these papers provoked no small amount of discussion. Since abstracts of all of them will soon appear in *Phytopathology* the subject matter will not be discussed here.

Resolutions were passed expressing the profound regret and deep sense of loss occasioned by the passing of Dr. G. R. Lyman, past president and secretary-treasurer of the American Phytopathological Society. A copy of the resolutions was sent to Mrs. Lyman and another was read upon the minutes of the society.

The very generous entertainment provided the visiting scientists by the city commissioners of Oakland was deeply appreciated by all. Boat rides about San Francisco Bay, to say nothing of automobile rides throughout the scenic regions of Alameda County, made it impossible for spare time to drag on any one's hands.

Similarly the sincere efforts on the part of the authorities of Mills College to provide every convenience for making the visitors comfortable and the meetings a success were acknowledged with gratitude.

Simplicity and informality struck the keynote of the meetings of the Pacific Division of the American Phytopathological Society this year, and the few days in June on which these meetings were held will not soon be forgotten.